

CLAIMS

WE CLAIM:

1. A photoinitiator system comprising:

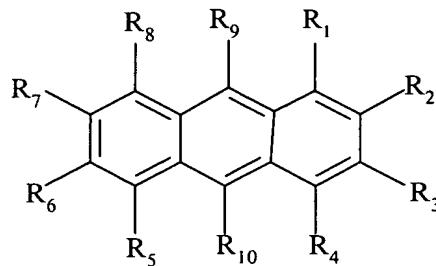
5 (a) an iodonium salt;

(b) a visible light sensitizer;

(c) a first anthracene that has a light absorption maximum less than about 400 nanometers; and

(d) a second anthracene having the following structure

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wherein each of R₁ to R₁₀ is independently selected from H, or alkyl, phenyl or alkoxy groups, provided that at least one of R₁ to R₁₀ is not H.

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2. A photopolymerizable composition comprising:

(a) a cationically polymerizable resin; and

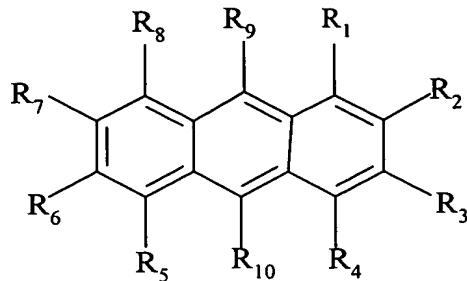
(b) a photoinitiator system for the cationically polymerizable resin, the photoinitiator system comprising:

20 (i) an iodonium salt;

(ii) a visible light sensitizer;

(iii) a first anthracene that has a light absorption maximum less than about 400 nanometers; and

(iv) a second anthracene having the following structure



wherein each of R₁ to R₁₀ is independently selected from H, alkyl, phenyl or alkoxy groups, provided that at least one of R₁ to R₁₀ is not H.

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3. The photopolymerizable composition according to claim 2, wherein the cationically polymerizable resin is selected from the group consisting of epoxy, oxetane, vinyl ether and spiro-orthocarbonate resins, and combinations thereof.

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4. The photopolymerizable composition according to claim 3, wherein the cationically polymerizable resin comprises an epoxy resin.

5. The photopolymerizable composition according to claim 4, wherein the cationically polymerizable resin comprises a silicon-containing epoxy resin.

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6. The photopolymerizable composition according to claim 3, wherein the cationically polymerizable resin comprises a blend of a silicon-containing epoxy resin and an epoxy resin that does not contain silicon.

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7. The photopolymerizable composition according to claim 2, wherein the iodonium salt is selected from the group consisting of diaryliodonium hexafluorophosphate, diaryliodonium hexafluoroantimonate, diaryliodonium tetrakis(pentafluorophenyl)borate, 4-octyloxyphenyl phenyliodonium hexafluoroantimonate, 4-(2-hydroxytetradecyloxyphenyl) phenyliodonium hexafluoroantimonate, 4-(1-methylethyl)phenyl 4-methylphenyliodonium tetrakis(pentafluorophenyl)borate, and combinations thereof.

8. The photopolymerizable composition according to claim 2, wherein the visible light sensitizer is selected from the group consisting of ketones, coumarin dyes, xanthene dyes, fluorone dyes, fluorescein dyes, aminoketone dyes, p-substituted aminostyryl ketone compounds, and combinations thereof.

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9. The photopolymerizable composition according to claim 2, wherein the visible light sensitizer is an alpha-diketone.

10 10. The photopolymerizable composition according to claim 9, wherein said alpha-diketone is camphorquinone.

11. The photopolymerizable composition according to claim 2, wherein the first anthracene is unsubstituted anthracene.

15 12. The photopolymerizable composition according to claim 2, wherein the second anthracene is selected from 2-ethyl-9,10-dimethoxyanthracene, 9,10-dimethylanthracene, 9,10-diethoxyanthracene, 1,4-dimethoxyanthracene, 9-methylanthracene, 2-ethylanthracene, 1,4-dimethoxyanthracene, 2-tert-butylanthracene, 2,6-di-tert-butylanthracene, and 9,10-diphenyl-2,6-di-tert-butylanthracene.

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13. The photopolymerizable composition according to claim 2, wherein the second anthracene is 2-ethyl-9,10-dimethoxyanthracene

25 14. The photopolymerizable composition according to claim 2, wherein the second anthracene is 9,10-dimethylanthracene.

15. The photopolymerizable composition according to claim 2, wherein the second anthracene is 9,10-diethoxyanthracene.

30 16. The photopolymerizable composition according to claim 2, wherein the second anthracene is 1,4-dimethoxyanthracene.

17. The photopolymerizable composition according to claim 2, wherein the second anthracene is 9-methylanthracene.

5 18. The photopolymerizable composition according to claim 2, wherein the second anthracene is 2-ethylanthracene.

10 19. The photopolymerizable composition according to claim 2, wherein at least one of R₁ to R₁₀ is tert-butyl.

15 20. The photopolymerizable composition according to claim 2, wherein the second anthracene is 2,6-di-tert-butylanthracene.

21. The photopolymerizable composition according to claim 2, further comprising a free-radically polymerizable resin.

22. The photopolymerizable composition according to claim 2, further comprising a hydroxyl-containing material.

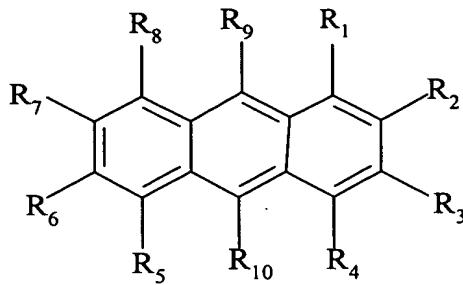
20 23. The photopolymerizable composition according to claim 2, wherein the photopolymerizable composition is a photopolymerizable adhesive.

24. A photoinitiator system comprising:

25 (a) an iodonium salt;
(b) a visible light sensitizer; and
(c) an electron donor comprising an alkoxy substituted anthracene.

25. The system of claim 24, further comprising a second electron donor compound having the following formula:

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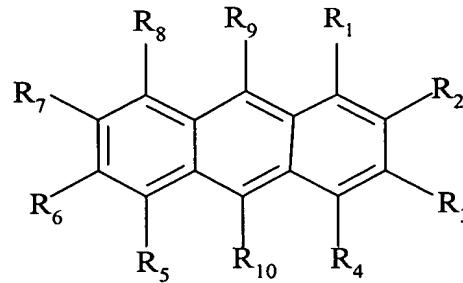
wherein each of R₁ to R₁₀ is independently selected from H, alkyl, phenyl or alkoxy groups.

5 26. A photopolymerizable composition comprising:

(a) a cationically polymerizable resin; and
 (b) a photoinitiator system for the cationically polymerizable resin, the photoinitiator system comprising:

- (i) an iodonium salt;
- (ii) a visible light sensitizer; and
- (iii) an electron donor comprising an alkoxy substituted anthracene.

10 27. The system of claim 26, further comprising a second electron donor having the following formula:



15 wherein each of R₁ to R₁₀ is independently selected from H, alkyl, phenyl or alkoxy groups.

20 28. The photopolymerizable composition according to claim 26, wherein the cationically polymerizable resin is selected from the group consisting of epoxy, oxetane, vinyl ether and spiro-orthocarbonate resins, and combinations thereof.

29. The photopolymerizable composition according to claim 28, wherein the cationically polymerizable resin comprises an epoxy resin.

5 30. The photopolymerizable composition according to claim 29, wherein the cationically polymerizable resin comprises a silicon-containing epoxy resin.

31. The photopolymerizable composition according to claim 28, wherein the cationically polymerizable resin comprises a blend of a silicon-containing epoxy resin and an epoxy resin that does not contain silicon.

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32. The photopolymerizable composition according to claim 26, wherein the iodonium salt is selected from the group consisting of diaryliodonium hexafluorophosphate, diaryliodonium hexafluoroantimonate, diaryliodonium tetrakis(pentafluorophenyl)borate, 4-octyloxyphenyl phenyliodonium hexafluoroantimonate, 4-(2-hydroxytetradecyloxyphenyl) phenyliodonium hexafluoroantimonate, 4-(1-methylethyl)phenyl 4-methylphenyliodonium tetrakis(pentafluorophenyl)borate, and combinations thereof.

20 33. The photopolymerizable composition according to claim 26, wherein the visible light sensitizer is selected from the group consisting of ketones, coumarin dyes, xanthene dyes, fluorone dyes, fluorescein dyes, aminoketone dyes, p-substituted aminostyryl ketone compounds, and combinations thereof.

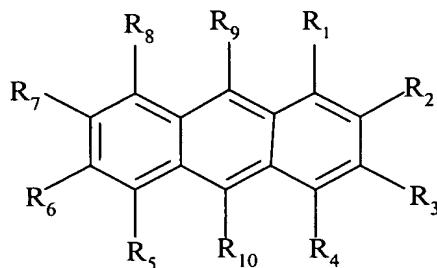
25 34. The photopolymerizable composition according to claim 26, wherein the visible light sensitizer is an alpha-diketone.

35. The photopolymerizable composition according to claim 34, wherein the alpha-diketone is camphorquinone.

36. The photopolymerizable composition according to claim 26, wherein the alkoxy substituted anthracene is selected from 2-ethyl-9,10-dimethoxyanthracene, 9,10-dimethoxyanthracene, 9,10-diethoxyanthracene, and 1,4-dimethoxyanthracene.

5 37. A photoinitiator system comprising:

- (a) an iodonium salt;
- (b) a visible light sensitizer;
- (c) a first anthracene and a second anthracene both having the following structure:



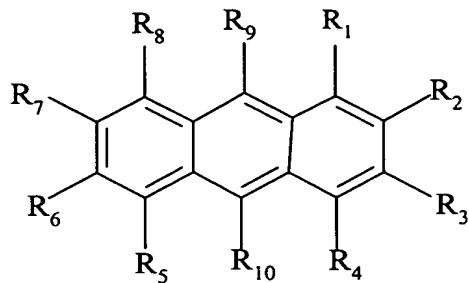
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wherein for said first anthracene each of R₁ to R₁₀ is independently selected from H, alkyl, phenyl, or alkoxy groups, provided that at least one of R₁ to R₁₀ is alkoxy, and wherein for said second anthracene each of R₁ to R₁₀ is independently selected from H, alkyl, phenyl or alkoxy groups.

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38. A photopolymerizable composition comprising:
(a) a cationically polymerizable resin; and
(b) a photoinitiator system for the cationically polymerizable resin, the photoinitiator system comprising:

20 (i) an iodonium salt;
(ii) a visible light sensitizer; and
(iii) a first anthracene and a second anthracene both having the following structure:



wherein for said first anthracene each of R₁ to R₁₀ is independently selected from H, alkyl, phenyl or alkoxy groups, provided that at least one of R₁ to R₁₀ is alkoxy, and
 wherein for said second anthracene each of R₁ to R₁₀ is independently selected from H,
 5 alkyl, phenyl or alkoxy groups.

39. The photopolymerizable composition according to claim 38, wherein the cationically polymerizable resin is selected from the group consisting of epoxy, oxetane, vinyl ether and spiro-orthocarbonate resins, and combinations thereof.

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40. The photopolymerizable composition according to claim 39, wherein the cationically polymerizable resin comprises an epoxy resin.

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41. The photopolymerizable composition according to claim 40, wherein the cationically polymerizable resin comprises a silicon-containing epoxy resin.

42. The photopolymerizable composition according to claim 39, wherein the cationically polymerizable resin comprises a blend of a silicon-containing epoxy resin and an epoxy resin that does not contain silicon.

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43. The photopolymerizable composition according to claim 38, wherein the iodonium salt is selected from the group consisting of diaryliodonium hexafluorophosphate, diaryliodonium hexafluoroantimonate, diaryliodonium tetrakis(pentafluorophenyl)borate, 4-octyloxyphenyl phenyliodonium hexafluoroantimonate, 4-(2-hydroxytetradecyloxyphenyl) phenyliodonium hexafluoroantimonate, 4-(1-methylethyl)phenyl 4-methylphenyliodonium tetrakis(pentafluorophenyl)borate, and combinations thereof.

44. The photopolymerizable composition according to claim 38, wherein the visible light sensitizer is selected from the group consisting of ketones, coumarin dyes, xanthene dyes, fluorone dyes, fluorescein dyes, aminoketone dyes, p-substituted aminostyryl ketone compounds, and combinations thereof.

5 45. The photopolymerizable composition according to claim 38, wherein the visible light sensitizer is an alpha-diketone.

10 46. The photopolymerizable composition according to claim 45, wherein said alpha-diketone is camphorquinone.

15 47. The photopolymerizable composition according to claim 38, wherein first anthracene is selected from 2-ethyl-9,10-dimethoxyanthracene, 9,10-diethoxyanthracene, and 1,4-dimethoxyanthracene.

20 48. A photopolymerizable composition according to claim 38, wherein second anthracene is selected from 2-ethyl-9,10-dimethoxyanthracene, 9,10-dimethylanthracene, 9,10-diethoxyanthracene, 1,4-dimethoxyanthracene, 9-methylanthracene, 2-ethylanthracene, 1,4-dimethoxyanthracene, 2-tert-butylanthracene, 2,6-di-tert-butylanthracene, and 9,10-diphenyl-2,6-di-tert-butylanthracene.

25 49. A photopolymerizable dental material comprising the photopolymerizable composition of claim 2, 26 or 38.

50. The photopolymerizable dental material of claim 49 further comprising at least one filler.

30 51. The photopolymerizable dental material of claim 50, wherein said filler is selected from quartz, submicron silica, and non-vitreous microparticles.

52. The photopolymerizable dental material of claim 49, further comprising at least one adjuvant.

5 53. The photopolymerization dental material of claim 52, wherein said adjuvant is selected from accelerators, inhibitors, absorbers, stabilizers, pigments, dyes, viscosity modifiers, surface tension depressants and wetting aids, antioxidants

10 54. A method for preparing a dental restorative or prosthesis, said method comprising:

- (a) providing the photopolymerizable dental material of claim 49; and
- (b) polymerizing the dental material by exposing it to light of an appropriate wavelength to provide said dental restorative or prosthesis.

15 55. The method of claim 54, further comprising the step of disposing said material into the mouth of a patient before or after step (b).

56. The method of claim 54, wherein said dental material is irradiated with light for a period of time less than 120 seconds.

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